Particle Imaging System Development for ICE-Ball

TCNJ MUSE 2020

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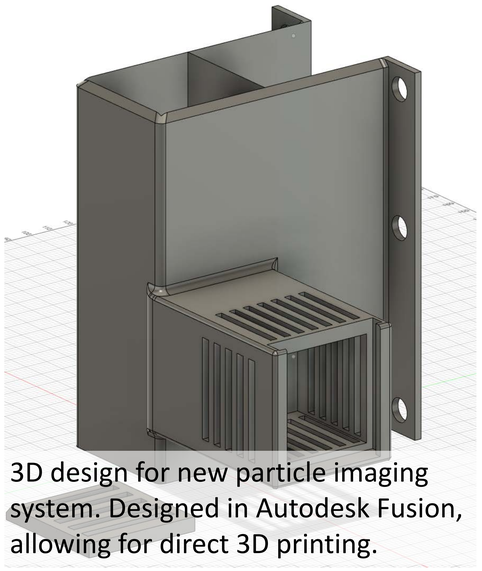
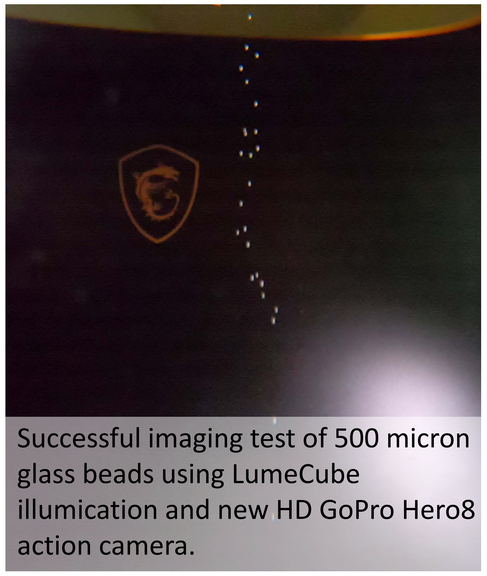
Zoom link for 9/15/2020 discussion:
https://tcnj.zoom.us/j/2021974612

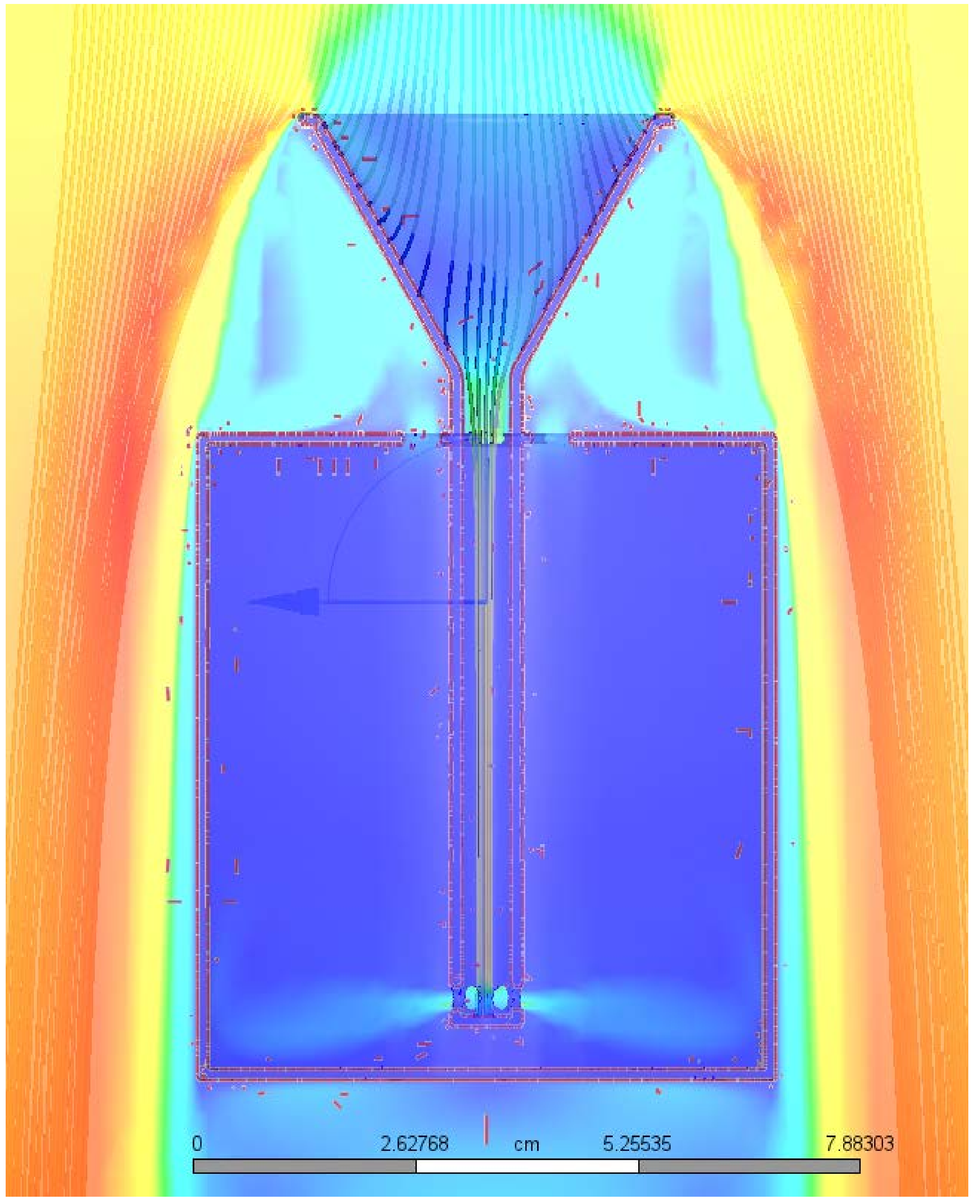


3D design for new particle imaging system. Designed in Autodesk Fusion, allowing for direct 3D printing.

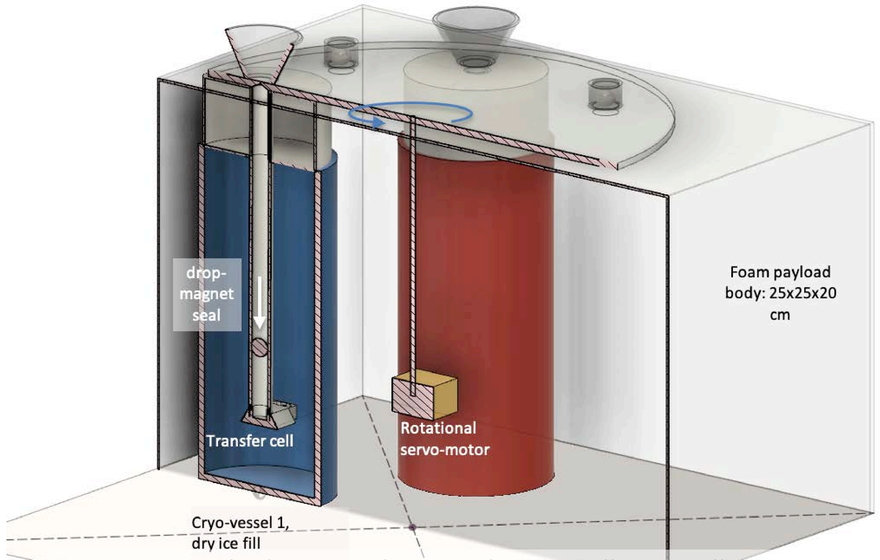
3D printed version of new particle imaging module.



Successful imaging test of 500 micron glass beads using LumeCube illumication and new HD GoPro Hero8 action camera.



Computational Fluid Dynamics Simulation (CFD) of 5 m/s airflow past ice particle collection module. The model projects that including holes at strategic locations in the capture tube will allow efficient collection of smaller ice particles (minimum w/ no holes 50 microns vs. approx. 25 microns w/ holes).



Cross-sectional schematic showing the ICE-Ball cryo-collection funnels and vessels that are filled with dry ice; they can seal cirrus particles in pristine condition for approx. 6 hours.

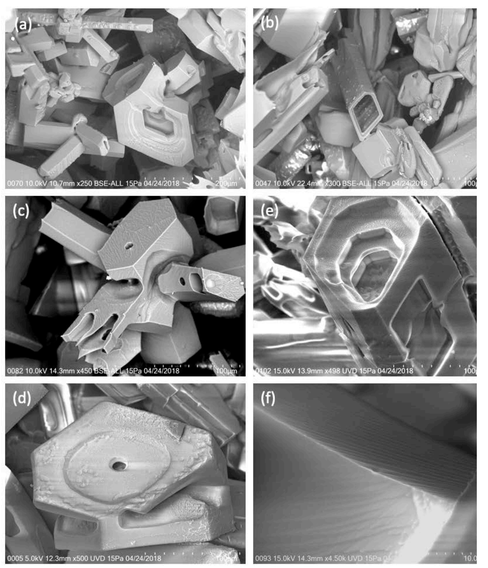
Project Overview and Motivation

This 2020 MUSE project was undertaken with a goal to further develop the technical capability of a novel balloon-borne instrument that has been designed and built by Dr. Magee and TCNJ students over the last few years. ICE-Ball (Ice Cryo Encapsulation by Balloon) carries a payload aloft to 60,000 ft. at 5 m/s, and uses a robotic capture mechanism to trap microscopic ice crystals from high-altitude cirrus clouds. The shape and texture of these tiny crystals plays an important role in cloud-sunlight energy balance, which in turn is a major uncertainty in climate change projections. Until now, only rough outlines of these particle have ever been seen, based on camera systems on the wings of research aircraft.

This summer we set out to add video imaging of these particles as ICE-Ball flies through cirrus clouds, which will enable measurement of ice particle number concentrations, which is an important input to climate models.

This new technical development will play a key role in the data acquired by ICE-Ball in a new TCNJ-PSU project funded by the US Dept. of Energy where ICE-Ball will be flown over state-of-the-art cloud-radar systems in Oklahoma.

TCNJ student Aaron Lynn, Nick Tusay, and author Xuanyi Zhao prior to ICE-Ball launch, July 2018.



Ice crystals collected from initial ICE-Ball flights during 207-2019 reveal never before seen structural details of cirrus ice particles. These results have important implications for cloud-climate feedbacks.